CLAMPING FORCE

PURPOSE OF TEST

Card-Lok retainers offer the highest clamping force available for cold wall applications. In a typical application two Card-Loks will be mounted either directly to the PCB or to a heat frame assembly via screws or rivets, and are then inserted into a machined cold wall channel within a rugged enclosure. When expanded, the Card-Lok will clamp the PCB in place. The amount of clamping force needed will depend on the application, specifically the amount of shock and vibration the board will be exposed to; too little clamping force may result in insufficient board retention and poor thermal performance and too great clamping force may result in damage to the Card-Lok, cold wall or printed circuit board.

EQUIPMENT

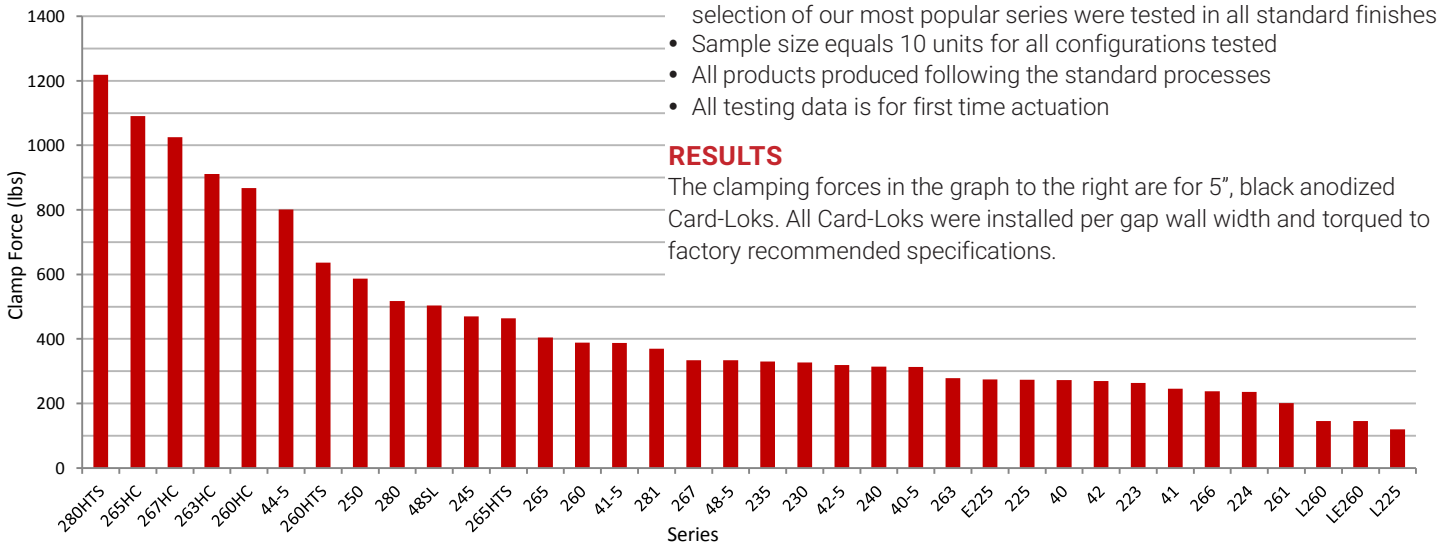
Since there is currently no industry standard for testing clamp force performance, our Engineers developed a test fixture. The fixture consisting of two stainless steel bars, one fixed and one floating, to simulate the cold wall channel. The floating bar pushes against two calibrated load cells that measure the normal force applied by the Card-lok when actuated. The new fixture is equipped with an automated screw driver that can quickly and accurately apply a specified torque. This allows us to test, measure, and accurately record clamp force data in seconds, allowing for more extensive cycle testing and continuous validation of product performance.

TEST PROCEDURE

- All standard products were tested with black anodized finish and a selection of our most popular series were tested in all standard finishes
- Sample size equals 10 units for all configurations tested
- All products produced following the standard processes
- All testing data is for first time actuation

RESULTS

The clamping forces in the graph to the right are for 5”, black anodized Card-Loks. All Card-Loks were installed per gap wall width and torqued to factory recommended specifications.



Testing has shown the wedge angle has the greatest impact on clamp force, with the HC series having 2-3x the clamp force of their traditional counterparts. Following the wedge angle, the number of wedge segments has the next greatest impact on clamp force performance; in general a five segment Card Lok will provide higher clamp force as compared to a similar profile three segment Card Lok. The High Thermal Sawtooth design provides similar clamp force as the HC series.

As compared to the wedge angle, and number of wedges, the surface finish has a lesser impact on clamping force. The chart to the right shows the percentage change in clamping force among various plating finishes. Of the four plating finishes tested, black anodized provided the highest clamping force, followed closely by hard black anodized and electroless nickel. Card Loks with chem film yielded less than half the clamping force compared to comparable Card Loks that were anodized.

		Benchmark plating (previously used / tested)			
		Black Anodized	Hard Black Anodized	Electroless Nickel	Chem Film
New plating considered for application	Black Anodized	0.0%	10.4%	15.4%	105.8%
	Hard Black Anodized	-9.5%	0.0%	4.5%	86.4%
	Electroless Nickel	-13.4%	-4.3%	0.0%	78.3%
	Chem Film	-51.4%	-46.3%	-43.9%	0.0%

THERMAL PERFORMANCE

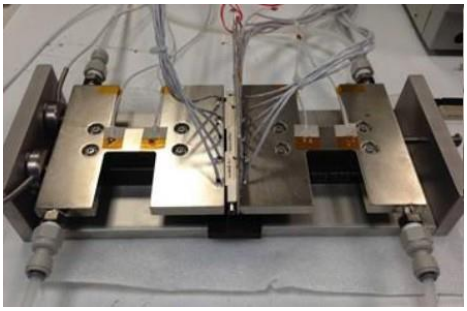
PURPOSE OF TEST

When two surfaces in contact have heat flowing across their junction, a measurable temperature difference arises caused by contact resistance.The purpose of this testing is to provide Design Engineers with a relative thermal resistance; actual performance will depend on the customer's application and environmental conditions. If the product is to be used in a critical application testing should be done to ensure desired results.

EQUIPMENT

Our Engineering team has developed a thermal test fixture consisting of a printed circuit board with polyimide film insulated heaters to simulate the hot components, resistance temperature detectors (RTDs) throughout the fixture for temperature measurement, a variable DC power supply, and two liquid cooled thermal plates to simulate the cold wall. The thermal test fixture can

- Accommodate a wide range of Card Loks and Wedge Lok size and designs
- Measure thermal resistance of the system and of the card lok independently
- Simultaneously measure clamp force.



TEST PROCEDURE

- All standard products were tested with black anodized finish and a selection of our most popular series were tested in all standard finishes
- Sample size equals 10 units for each Card Lok configuration
- Testing was conducted at sea level. If performed at high altitude or near vacuum conditions, increases of 10 to 40 percent would not be unusual
- Heat dissipation due to convection and radiation were minimized

RESULTS

The chart to the right provides the estimated temperature rise across the interface (junction) of the card and cold plate. The chart below shows the relative impact of plating finish on the thermal resistance, lower values are indicative of better thermal performance. Among the four plating finishes tested, electroless nickel is best, followed by chemical film, black anodized and hard black anodized are the least effective for thermal performance.

		From Plating Finish (previosly used / tested)			
		Electroless Nickel	Chem Film	Black Anodized	Hard Black Anodized
New plating considered for application	Electroless Nickel	0.0%	-3.1%	-9.2%	-12.4%
	Chem Film	3.2%	0.0%	-6.3%	-9.5%
	Black Anodized	10.2%	6.7%	0.0%	-3.5%
	Hard Black Anodized	14.1%	10.6%	3.6%	0.0%

Thermal performance is based on many application and environmental factors. If a series Card Lok has already been tested in an application, the chart below can provide comparative performance, providing the percent change in thermal resistance between two series Card Loks. For example, if the thermal performance of the series 280 is known for a given application, under the same conditions, changing to the 280HTS will reduce the total interface resistance by 19,3%.

		Benchmark series (previously used / tested in your application)																																
		280HTS	260HTS	44-5	280	265HTS	267HC	263HC	260HC	48-5	265HC	48SL	41-5	265	263	260	40-5	224	250	267	42-5	L260	LE260	281	235	245	225	E225	40	261	42	240	230	266
New series considered for application	280HTS	0,0%	-12,5%	-15,5%	-19,3%	-19,8%	-21,2%	-21,9%	-22,1%	-22,8%	-23,0%	-27,4%	-28,5%	-28,6%	-29,8%	-30,3%	-31,9%	-33,1%	-33,2%	-33,5%	-33,6%	-34,5%	-34,5%	-34,6%	-37,0%	-37,4%	-38,8%	-38,8%	-40,3%	-40,3%	-41,6%	-42,2%	-43,2%	-46,5%
	260HTS	14,3%	0,0%	-3,5%	-7,8%	-8,4%	-9,9%	-10,8%	-11,0%	-11,8%	-12,0%	-17,1%	-18,3%	-18,4%	-19,7%	-20,3%	-22,2%	-23,5%	-23,6%	-24,0%	-24,1%	-25,1%	-25,1%	-25,3%	-28,0%	-28,5%	-30,0%	-30,0%	-31,8%	-31,8%	-33,3%	-33,9%	-35,0%	-38,9%
	44-5	18,4%	3,6%	0,0%	-4,5%	-5,1%	-6,7%	-7,5%	-7,8%	-8,6%	-8,8%	-14,1%	-15,4%	-15,5%	-16,9%	-17,5%	-19,4%	-20,8%	-20,9%	-21,3%	-21,4%	-22,4%	-22,4%	-22,6%	-25,4%	-25,9%	-27,5%	-27,5%	-29,3%	-29,4%	-30,9%	-31,6%	-32,7%	-36,7%
	280	23,9%	8,2%	4,7%	0,0%	-0,7%	-2,3%	-3,2%	-3,5%	-4,3%	-4,6%	-10,1%	-11,4%	-11,5%	-13,0%	-13,6%	-15,7%	-17,1%	-17,2%	-17,6%	-21,4%	-18,8%	-18,8%	-19,0%	-21,9%	-22,5%	-24,1%	-24,1%	-26,0%	-26,1%	-27,7%	-28,4%	-29,6%	-33,7%
	265HTS	24,8%	8,5%	5,4%	0,7%	0,0%	-1,7%	-2,6%	-2,9%	-3,7%	-3,9%	-9,5%	-10,8%	-10,9%	-12,4%	-13,0%	-15,1%	-16,5%	-16,6%	-17,1%	-17,7%	-18,2%	-18,2%	-18,4%	-21,3%	-21,9%	-23,6%	-23,6%	-25,5%	-25,6%	-27,2%	-27,9%	-29,1%	-33,2%
	267HC	26,9%	10,1%	7,2%	2,4%	1,7%	0,0%	-0,9%	-1,2%	-2,1%	-2,3%	-7,9%	-9,3%	-9,4%	-10,9%	-11,5%	-13,6%	-15,1%	-15,2%	-15,7%	-15,7%	-16,8%	-16,8%	-17,0%	-20,0%	-20,6%	-22,3%	-22,3%	-24,2%	-24,3%	-25,9%	-26,6%	-27,9%	-32,1%
	263HC	28,0%	10,9%	8,2%	3,3%	2,6%	0,9%	0,0%	-0,3%	-1,2%	-1,4%	-7,1%	-8,5%	-8,6%	-10,1%	-10,7%	-12,9%	-14,3%	-14,4%	-14,9%	-15,0%	-16,1%	-16,1%	-16,3%	-19,3%	-19,9%	-21,6%	-21,6%	-23,5%	-23,6%	-25,3%	-26,0%	-27,2%	-31,5%
	260HC	28,4%	11,1%	8,5%	3,7%	3,0%	1,2%	0,3%	0,0%	-0,9%	-1,1%	-6,8%	-8,2%	-8,3%	-9,8%	-10,5%	-12,6%	-14,1%	-14,1%	-14,6%	-14,7%	-15,8%	-15,8%	-16,0%	-19,0%	-19,6%	-21,3%	-21,3%	-23,3%	-23,4%	-25,0%	-25,7%	-27,0%	-31,3%
	48-5	29,5%	11,9%	9,4%	4,5%	3,8%	2,1%	1,2%	0,9%	0,0%	-0,2%	-6,0%	-7,4%	-7,5%	-9,0%	-9,7%	-11,8%	-13,3%	-13,4%	-13,9%	-14,0%	-15,1%	-15,1%	-15,3%	-18,3%	-18,9%	-20,7%	-20,7%	-22,6%	-22,7%	-24,4%	-25,1%	-26,4%	-30,7%
	265HC	29,8%	12,0%	9,7%	4,8%	4,1%	2,3%	1,4%	1,1%	0,2%	0,0%	-5,8%	-7,2%	-7,3%	-8,8%	-9,5%	-11,6%	-13,1%	-13,2%	-13,7%	-13,8%	-14,9%	-14,9%	-15,1%	-18,1%	-18,8%	-20,5%	-20,5%	-22,5%	-22,5%	-24,2%	-24,9%	-26,2%	-30,5%
	48SL	37,8%	18,1%	16,4%	11,2%	10,5%	8,6%	7,7%	7,3%	6,4%	6,2%	0,0%	-1,5%	-1,6%	-3,2%	-3,9%	-6,2%	-7,8%	-7,9%	-8,4%	-8,5%	-9,7%	-9,7%	-9,9%	-13,1%	-13,8%	-15,6%	-15,6%	-17,7%	-17,8%	-19,6%	-20,3%	-21,7%	-26,2%
	41-5	39,9%	18,6%	18,2%	12,9%	12,2%	10,3%	9,3%	8,9%	8,0%	7,8%	1,5%	0,0%	-0,1%	-1,7%	-2,5%	-4,8%	-6,4%	-6,5%	-7,0%	-7,1%	-8,3%	-8,3%	-8,5%	-11,8%	-12,5%	-14,3%	-14,3%	-16,4%	-16,5%	-18,3%	-19,1%	-20,5%	-25,1%
	265	40,1%	18,4%	18,3%	13,0%	12,3%	10,4%	9,4%	9,0%	8,1%	7,9%	1,6%	0,1%	0,0%	-1,6%	-2,4%	-4,7%	-6,3%	-6,4%	-6,9%	-7,0%	-8,2%	-8,2%	-8,4%	-11,7%	-12,4%	-14,2%	-14,2%	-16,3%	-16,4%	-18,2%	-19,0%	-20,4%	-25,0%
	263	42,4%	20,1%	20,3%	14,9%	14,1%	12,2%	11,2%	10,8%	9,9%	9,7%	3,3%	1,8%	1,6%	0,0%	-0,7%	-3,1%	-4,7%	-4,8%	-5,4%	-5,5%	-6,7%	-6,7%	-6,9%	-10,2%	-10,9%	-12,8%	-12,8%	-15,0%	-15,1%	-16,9%	-17,7%	-19,1%	-23,8%
	260	43,4%	20,5%	21,2%	15,8%	15,0%	13,0%	12,0%	11,7%	10,7%	10,5%	4,1%	2,5%	2,4%	0,8%	0,0%	-2,4%	-4,0%	-4,1%	-4,6%	-4,7%	-6,0%	-6,0%	-6,2%	-9,6%	-10,2%	-12,1%	-12,1%	-14,3%	-14,4%	-16,3%	-17,1%	-18,5%	-23,2%
	40-5	46,9%	22,8%	24,1%	18,6%	17,8%	15,8%	14,8%	14,4%	13,4%	13,2%	6,6%	5,0%	4,9%	3,2%	2,4%	0,0%	-1,7%	-1,8%	-2,3%	-2,4%	-3,7%	-3,7%	-3,9%	-7,4%	-8,1%	-10,0%	-10,0%	-12,3%	-12,3%	-14,3%	-15,1%	-16,5%	-21,4%
	224	49,4%	23,9%	26,2%	20,6%	19,8%	17,8%	16,7%	16,4%	15,4%	15,1%	8,4%	6,8%	6,7%	5,0%	4,2%	1,7%	0,0%	-0,1%	-0,7%	-0,8%	-2,1%	-2,1%	-2,3%	-5,8%	-6,5%	-8,5%	-8,5%	-10,7%	-10,8%	-12,8%	-13,6%	-15,0%	-20,0%
	250	49,6%	23,6%	26,4%	20,7%	19,9%	17,9%	16,9%	16,5%	15,5%	15,2%	8,5%	6,9%	6,8%	5,1%	4,3%	1,8%	0,1%	0,0%	-0,6%	-0,7%	-2,0%	-2,0%	-2,1%	-5,7%	-6,4%	-8,4%	-8,4%	-10,6%	-10,7%	-12,7%	-13,5%	-15,0%	-19,9%
	267	50,4%	24,2%	27,1%	21,4%	20,6%	18,6%	17,5%	17,1%	16,1%	15,9%	9,1%	7,5%	7,4%	5,7%	4,9%	2,4%	0,7%	0,6%	0,0%	-0,1%	-1,4%	-1,4%	-1,6%	-5,2%	-5,9%	-7,9%	-7,9%	-10,2%	-10,2%	-12,2%	-13,0%	-14,5%	-19,5%
	42-5	50,6%	24,1%	27,2%	21,5%	20,7%	18,7%	17,6%	17,2%	16,2%	16,0%	9,3%	7,6%	7,5%	5,8%	5,0%	2,5%	0,8%	0,7%	0,1%	0,0%	-1,3%	-1,3%	-1,5%	-5,1%	-5,8%	-7,8%	-7,8%	-10,1%	-10,2%	-12,1%	-12,9%	-14,4%	-19,4%
	L260	52,6%	25,5%	28,9%	23,1%	22,3%	20,3%	19,2%	18,8%	17,8%	17,5%	10,7%	9,1%	8,9%	7,2%	6,4%	3,9%	2,1%	2,0%	1,4%	1,3%	0,0%	0,0%	-0,2%	-3,8%	-4,5%	-6,5%	-6,5%	-8,9%	-9,0%	-10,9%	-11,8%	-13,3%	-18,3%
	LE260	52,6%	25,1%	28,9%	23,1%	22,3%	20,3%	19,2%	18,8%	17,8%	17,5%	10,7%	9,1%	8,9%	7,2%	6,4%	3,9%	2,1%	2,0%	1,4%	1,3%	0,0%	0,0%	-0,2%	-3,8%	-4,5%	-6,5%	-6,5%	-8,9%	-9,0%	-10,9%	-11,8%	-13,3%	-18,3%
	281	52,9%	25,3%	29,2%	23,4%	22,6%	20,5%	19,4%	19,0%	18,0%	17,8%	10,9%	9,3%	9,2%	7,4%	6,6%	4,1%	2,3%	2,2%	1,6%	1,5%	0,2%	0,2%	0,0%	-3,6%	-4,3%	-6,4%	-6,4%	-8,7%	-8,8%	-10,8%	-11,6%	-13,1%	-18,2%
	235	58,6%	29,0%	34,0%	28,0%	27,1%	25,0%	23,9%	23,5%	22,4%	22,2%	15,1%	13,4%	13,2%	11,4%	10,6%	8,0%	6,1%	6,0%	5,4%	5,3%	3,9%	3,9%	3,7%	0,0%	-0,8%	-2,9%	-2,9%	-5,3%	-5,4%	-7,4%	-8,3%	-9,8%	-15,1%
	245	59,8%	28,7%	35,0%	29,0%	28,1%	26,0%	24,8%	24,4%	23,4%	23,1%	16,0%	14,2%	14,1%	12,3%	11,4%	8,8%	6,9%	6,8%	6,2%	6,1%	4,7%	4,7%	4,5%	0,8%	0,0%	-2,1%	-2,1%	-4,5%	-4,6%	-6,7%	-7,6%	-9,1%	-14,5%
	225	63,3%	30,7%	37,9%	31,8%	30,9%	28,7%	27,5%	27,1%	26,0%	25,8%	18,5%	16,7%	16,6%	14,7%	13,8%	11,1%	9,3%	9,1%	8,5%	8,4%	7,0%	7,0%	6,8%	2,9%	2,2%	0,0%	0,0%	-2,5%	-2,6%	-4,7%	-5,6%	-7,2%	-12,6%
	E225	63,3%	30,0%	37,9%	31,8%	30,9%	28,7%	27,5%	27,1%	26,0%	25,8%	18,5%	16,7%	16,6%	14,7%	13,8%	11,1%	9,3%	9,1%	8,5%	8,4%	7,0%	7,0%	6,8%	2,9%	2,2%	0,0%	0,0%	-2,5%	-2,6%	-4,7%	-5,6%	-7,2%	-12,6%
	40	67,4%	32,6%	41,4%	35,1%	34,2%	32,0%	30,8%	30,4%	29,2%	29,0%	21,5%	19,7%	19,5%	17,6%	16,7%	14,0%	12,0%	11,9%	11,3%	11,2%	9,7%	9,7%	9,5%	5,6%	4,8%	2,6%	2,6%	0,0%	-0,1%	-2,3%	-3,2%	-4,8%	-10,4%
	261	67,6%	31,9%	41,6%	35,3%	34,3%	32,1%	30,9%	30,5%	29,4%	29,1%	21,6%	19,8%	19,7%	17,7%	16,8%	14,1%	12,1%	12,0%	11,4%	11,3%	9,8%	9,8%	9,6%	5,7%	4,9%	2,7%	2,7%	0,1%	0,0%	-2,2%	-3,1%	-4,7%	-10,3%
	42	71,3%	34,1%	44,7%	38,3%	37,3%	35,0%	33,8%	33,4%	32,3%	32,0%	24,3%	22,5%	22,3%	20,3%	19,4%	16,6%	14,6%	14,5%	13,9%	13,8%	12,3%	12,3%	12,1%	8,0%	7,2%	4,9%	4,9%	2,3%	2,2%	0,0%	-0,9%	-2,6%	-8,3%
	240	73,0%	34,3%	46,1%	39,6%	38,6%	36,3%	35,1%	34,7%	33,5%	33,2%	25,5%	23,6%	23,5%	21,5%	20,6%	17,7%	15,7%	15,6%	15,0%	14,9%	13,4%	13,4%	13,1%	9,0%	8,2%	5,9%	5,9%	3,3%	3,2%	1,0%	0,0%	-1,7%	-7,4%
	230	75,9%	35,6%	48,6%	42,0%	41,0%	38,6%	37,4%	37,0%	35,8%	35,5%	27,6%	25,7%	25,6%	23,6%	22,6%	19,7%	17,7%	17,6%	16,9%	16,8%	15,3%	15,3%	15,1%	10,9%	10,1%	7,7%	7,7%	5,1%	5,0%	2,7%	1,7%	0,0%	-5,9%
	266	86,9%	41,3%	57,9%	50,8%	49,8%	47,3%	46,0%	45,5%	44,2%	43,9%	35,6%	33,6%	33,4%	31,3%	30,3%	27,2%	25,0%	24,9%	24,2%	24,1%	22,5%	22,5%	22,2%	17,8%	16,9%	14,5%	14,5%	11,6%	11,5%	9,1%	8,0%	6,2%	0,0%

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